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Review Article

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DOES CONCOCTION OF ORGANIC AND INORGANIC FERTILIZATION HAVE POTENTIAL TO ENHANCE WHEAT YIELD?

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ABSTRACT. Soil fertility and maximum crop production can only be achieved through proper fertilization. Proper and balanced fertilization have a considerably positive effect on plant growth and yield. Due to continuous use of chemical fertilizers, the organic matter and nutrient content of the soil decreased gradually. Therefore, in modern era, agriculture scientists are now engaged to establish an agricultural system, which can not only lower the production cost, but also conserve the natural resources. Soil, as a source of nutrients, must be protected from various kinds of external factors, especially from the addition of fertilizers in excessive rates. Any degradation in the quality of soil can significantly produce many undesirable changes in the environment and also reduces the overall crop yield. So, the concoction of organic and inorganic fertilization is an alternative and most effective method for sustainable and cost-effective management for maximum crop production, without effecting the environment. The Integrated Nutrient Management provides an excellent opportunity not only for sustainability of the soil, but also enhances the overall crop productivity. The present review study was carried out with the main aim to evaluate the role of combined application of organic and inorganic fertilizers on wheat crop production. The outcome of the study concluded that combined application of both organic and inorganic fertilizers significantly improve the wheat crop production, as compared with the sole application of either organic or inorganic fertilizers.

Keywords: wheat; fertilizers; integrated nutrient management; NPK.

INTRODUCTION

Most of Pakistan soils are calcareous in nature, alkaline in reaction, low in organic matter content and almost deficient in essential plant nutrients (Jamal and Jamal, 2018). The prevailing soil and

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environmental conditions not only reduce the efficacy of mineral fertilizers, but also ultimately affect the productivity of crop (Jamal and Fawad, 2018).

Wheat (*Triticum aestivum* L.) is one of the most leading cereal crop, used almost all over the world as major staple food, as it is the most cheap and instant source of carbohydrates, proteins minerals, as well as vitamins in traces (Walton, 1969). With rapidly increasing population, the demand of food is increasing, so there is great need to increase the productivity of wheat. Though Pakistan is the 10^{th} largest wheat grower country in the world and cultivated wheat on large area of 9.18 million hectares with a total production of 25.5 million tons, yet the production is far below as compared with other wheat growing countries (Jamal *et al*., 2018).

Soil fertility degradation, poor crop management, nutrients deficiency and imbalanced fertilizations are the critical factors reducing wheat yield in many countries of the world (Ahmad *et al.,* 2013). Among mostly growers, the application of mineral fertilizers are common for managing deficiencies of primary macro nutrients, like nitrogen (N), phosphorus (P) and potassium (K). However, management of some secondary macro and micronutrients is completely ignored; moreover, intensive cultivation of high yielding crop varieties, without proper management, not only reduced the soil nutrient reservoirs, but also reduced nutrients use efficiency (Phullan *et al*., 2017). Continuous application of inorganic fertilizers to soil not only threaten the environment, but also pollute the surface and sub-surface water reserves by leaching down into the soil (Jamal and Fawad 2018).

Integrated Nutrient Management (INM)

It is an established phenomenon that neither organic manures, nor chemical fertilizers used alone can achieve the yield sustainability at a higher order under the modern intensive farming, in which the nutrient turnover in the soil-plant system has been quite high. In modern era, there is a growing interest of organic manure because of the high prices of inorganic fertilizers in the developing countries, as well as the energy crises throughout the world (Abbas *et al.*, 2012). The influence of organic fertilizers improves soil physical structure, as well as supply a variety of nutrients to the crop (Ahmad *et al.,* 2013), which also ultimately decrease the soil bulk density up to a great extent (Sharma *et al*., 2013).

Application of organic manure improves soil organic matter content, as well as the total nitrogen content of the soil (Mann and Ashraf, 2000). However, the uses of only organic manures have some limitation too, organic fertilizers are derived from substance like animal feces or plant matter contaminated with pathogen, which are extremely dangerous to

human, as well as plants; in addition, organic fertilizers are relatively low in nutrient content and hence required in huge amount to supply proper amount of nutrients to the crops (Vanlauwe *et al*, 2010). Integrated Plant Nutrition Management (IPNM) can be the best alternate approach for better crop production and sustainable soil health, the best possible way to increase soil productivity, as well as soil fertility is the integration of both inorganic and organic fertilizers (Jamal *et al.,* 2019). Integrated approach not only increases the crop yield, but also sustain agriculture productivity (Ahmad *et al.*, 2013).

Effect of organic and inorganic fertilizers on wheat growth parameters

Published literature revealed that of organic and inorganic fertilizers significantly improved wheat growth parameters. Maximum plant height of 78.33 cm was reported with the combined application of SSP (100 kg ha^{-1}) + PM (6 t ha^{-1}) (Jamal *et al.,* 2019). Mixed application of organic and inorganic fertilizers may improved wheat plant height significantly (Delden, 2001). The results are in lined with those of the findings of (Abbas *et al.,* 2012). They reported maximum plant height (cm), spike length (cm), number of spikelets per spike with the application of 6 t ha^{-1} poultry manure + 128-114-62 kg ha^{-1} NPK. Wheat growth parameters can be significantly increased with the combined application of organic and inorganic fertilizers, the maximum plant height was recorded with the combinations of NPK+ PM 50 kg ha^{-1}, which was 102.53 cm, while maximum number of tillers per plant (343) and wheat maximum spike length of 13.65 cm was recorded with the application of recommended dose of NPK + city compost 300 kg $acre^{-1}$ (Ahmad *et al.,* 2013).

Organic farming approach with chemical fertilizers seems to be the best possible solution to increase crop growth. The result of an experiment conducted by Jamil *et al.* (2006) revealed that maximum wheat plant height of 107 cm can be successfully achieved with the application of sewage sludge at 80 t ha^{-1} along with recommended doses of NPK fertilizers. Integrated use of organics and chemical fertilizers has been found to be more promising in improving the growth parameters in wheat crop. Integrated use of 30 t ha^{-1} FYM with NPK at 80-60-60 kg ha^{-1} resulted in significant increase in wheat growth parameters (Rehman *et al.*, 2008).

Integrated nutrient management practices significantly improved the growth and yield parameters over the rest of the treatments (Singh *et al.,* 2001). The results are in accordance with those of Singh and Agarwal (2001). They reported that application of mineral nitrogen in combination with organic nitrogen significantly increased plant height due to efficient role of nitrogen in cell division and enlargement, which ultimately effect the vegetative growth of plant specially plant height. The increase in

growth parameters of wheat crop with application of integrated organic and inorganic fertilizers might be due to addition of more nutrients and growth promoting substances through organic manures.

Effect of organic and inorganic fertilizers on wheat yield and yield components

It has been found that integrated use of both organic manures and chemical fertilizers enhance the productivity in intensive cropping systems, as compared to chemical fertilizer alone. The result of the study conducted by Phullan *et al.* (2017) revealed that farmyard manure at 6 t ha^{-1}, coupled with mineral fertilizer rate of 120-90 kg N-P_2O_5 ha^{-1}, was the best source for maximum wheat production. Shah *et al.* (2010) concluded that integrated use of both organic and inorganic fertilizers can enhance wheat growth, as well as yield components. They reported maximum grain yield of 3.5 t ha^{-1} from treatments, where 25% N was applied from FYM 25% N from poultry manure or city waste and 50% from mineral source and in treatment, where 25% N was applied from FYM, 25% from city waste and 50% from mineral fertilizer.

Akhtar *et al.* (2011) reported that green manure at 4 t ha^{-1} + NPK fertilizers at 150-100-50 kg ha^{-1} produced maximum grain yield of 5803 kg ha^{-1}. Similarly, Jamal *et al.* (2019) achieved maximum grain yield of 4.63 t ha^{-1} with the application of mineral phosphorous at 100 kg ha^{-1} in combination with 6 t ha^{-1} poultry manure, while the results of Abbas *et al.* (2012) revealed that maximum wheat yield can be achieved with the application of poultry manure at 6 t ha^{-1} + 128-114-62 kg ha^{-1} NPK. Significant increase in wheat grain yield was observed with the combined application of 6 t poultry manure, 6 t farm yard manure ha^{-1} and 90 kg N ha^{-1} (Khan *et al.*, 2014). Organic and inorganic fertilizers in combination have strong potential to enhance wheat grain yield up to a great extent. The study of Ahmad *et al.* (2013) revealed that recommended doses of NPK along with press mud at 500 kg ha^{-1} produced the maximum wheat grain yield of 3.14 t ha^{-1}.

Shah *et al.* (2012) concluded that application of 25% N from poultry manure and 75% N from mineral fertilizers produced maximum grain yield of wheat (3248 kg ha^{-1}) and concluded that combination of 25:75 organic and mineral N sources could be the best combination to achieve most profitable yield of wheat crop. Similarly, the results of Abedi *et al.* (2010) revealed that highest wheat grain could be obtained with the application of 160 kg N ha^{-1} and 30 Mg compost ha^{-1}. Moreover, they evaluated the positive impact of organic compost application on reduction of chemical fertilizers use. Outcomes of field experiments conducted by Zahir *et al.* (2007) showed that wheat growth and yield components could be improved significantly with the application of N and L-tryptophan (L-TRP) enriched

compost at 500 kg ha^{-1} saving 30 % N fertilizer.

Rehman *et al.* (2008) evaluated the importance of FYM in combination with mineral NPK fertilizers and concluded that with application of FYM at 30 t ha^{-1} along with 80-60-60 kg NPK ha^{-1} produced maximum wheat yield components and biomass under rainfed condition. These results are in agreements with Jala-Abadi *et al.* (2012). They clearly indicated that with application of organic and inorganic fertilizers in combination the grain yield, biological yield, harvest index, 1000-grain weight and chlorophyll content increased significantly, as compared with either organic or inorganic fertilizers applied alone.

The study of Muhammad *et al*. (2013) proposed that chemical fertilizers applied with bio-fertilizers significantly improved wheat growth, as well as yield parameters. They reported maximum grain yield of 4356.50 kg ha^{-1} with application of 168-84-50 kg ha^{-1} NPK fertilizers. The outcomes of Akhtar *et al.* (2009) showed that maximum increase in plant height, number of tillers m^{-2}, number of spikelets $spike^{-1}$, grain and straw yield were recorded with the use of plant growth promoting rhizobacteria (PGPR) inoculated seeds in combination with compost and chemical fertilizers. Devi *et al*. (2011) obtained maximum grain yield and biological yield with the application of 100% RDF+ vermicompost at 1t ha^{-1}+ PSB and 75% RDF+ vermicompost at 1t ha^{-1}+ PSB (4.89 t ha^{-1}). Similarly, Ahmed *et al.* (2011) concluded that all the growth parameters of wheat significantly affected by inoculation of wheat grain with bio-organic fertilizers.

Mean rice and wheat yields obtained from combined application of 100% recommended NPK through inorganic fertilizers + organic manures (FYM or *Sesbania* green manure) were significantly higher than those obtained under the application of 100% NPK through chemical fertilizers alone (Yaduvanshi, 2001). These results are in lined with Patro *et al.* (2005), which obtained highest total productivity of rice-wheat with *Sesbania* green manure along with 180 kg N ha^{-1} applied to rice and 150 kg N ha^{-1} applied to wheat in sequence. Similarly, Singh and Kumar (2010) found that 25 or 50% of recommended N through FYM, pressmud and paddy straw and the rest of recommended N through inorganic fertilizers gave significantly higher grain and straw yields of both rice and wheat over 75% of recommended N through organic sources and 25% recommended N through inorganic fertilizers. Application of 100% NPK + FYM resulted in significant increase in grain yield of wheat, as compared to 100% or 150% NPK alone (Verma, 2003). The results of Shivkumar and Ahlawat (2008) showed that 100% RDF + 5 t FYM ha^{-1} significantly gave higher wheat yield than chemical fertilizers applied alone.

CONCLUSIONS

From this review it can be concluded that combined application of organic and inorganic fertilizers has remarkable effect on growth and yield components of wheat crop. Furthermore, the excess use of chemical fertilizers can lead to soil acidification and environmental pollution. The integrated nutrients management system is an alternative and a more effective approach to sustain soil fertility, as well as crop productivity up to a great extent. Combined application of organic and inorganic fertilizers to crop not only improves the crop productivity, but also reduced input cost of chemical fertilizers, as well as its negative impact on the environment. Concoction of organic and inorganic fertilization was strongly recommended for sustainable soil fertility and wheat crop productivity.

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